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Effectiveness of virtual classroom training in improving the knowledge and key maternal neonatal health skills of general nurse midwifery students in Bihar, India: A pre- and post-intervention study

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SUMMARY

Background: In 2008–09, the National Health Systems Resource Center of India reported overall quality of nurse-midwifery education in Bihar as grossly sub-optimal. To address this, we implemented a competency-based training using virtual classrooms in two general nurse midwives (GNM) schools of Bihar. The students from remotely located nursing institutions were now able to see live demonstrations of maternal and newborn health (MNH) practices performed by a trained faculty on simulation models at instructor location.
Objective: To evaluate the effectiveness of virtual classroom training in improving the MNH-related skills of the nursing-midwifery students in Bihar, India.
Design: This study used a pre- and post-intervention design without a control group.
Settings: Students from two public GNM schools of Bihar.
Participants: Final-year students from both the GNM schools who have completed their coursework in MNH.
Method: A total of 83 students from selected GNM schools were assessed for their competencies in six key MNH practices using objective structured clinical examination method prior to intervention. A 72 hour standardized training package was then implemented in these schools through virtual classroom approach. Post-intervention, 92 students from the next batch who attended virtual training were assessed for the same competencies.
Results: The mean student score assessed before the intervention was 21.3 (95% CI, 19.9–22.6), which increased to 62.0 (95% CI, 60.3–63.7) post-intervention. This difference was statistically significant. When adjusted for clustering using linear regression analysis, the students in post-intervention scored 52.3 (95% CI, 49.4%–55.3%) percentage points higher than pre-intervention, and this was statistically significant.
Conclusion: Virtual classroom training was found to be effective in improving knowledge and key MNH skills of GNM students in Bihar, India.

Introduction

Optimum midwifery services is among the most effective ways in providing high-quality maternal, newborn care and thus in reducing maternal and infant mortality especially in developing countries (Renfrew et al., 2014; ten Hoope-Bender et al., 2014). Some of the key causes for maternal and neonatal deaths like infection, post-partum hemorrhage, eclampsia, birth asphyxia, and pre-term birth can be averted through competent nursing-midwifery care (WHO, 2014a). With the launch of Global Strategies for Women's and Children's Health in 2010, many developing countries started prioritizing their focus on improving access to quality midwifery services to women during intra-partum, post-partum period by scaling up the numbers of competent nurses-midwives as part of their national agenda (UNFPA, 2011).

In India, the current shortage of nursing-midwifery workforce is a major human resource constraint for providing quality maternal and child health services and thus in achieving Millennium Development Goals 4, 5 by 2015 (Hazarika, 2013). Although significant improvements have been observed in the percentage live births attended by skilled health personnel from 1992–93 to 2007–08 (WHO and UNICEF, 2010), there exists an acute shortage of more than 2 million nursing staff (WHO, 2014b).

In Bihar, the scenario is even more alarming as the shortfall in the number of staff nurses is around 50% in the medical college hospitals and much higher in the public health facilities. Similarly, the shortfall of the multipurpose health workers, i.e. auxiliary nurse midwives (ANMs), in the existing public health facilities of Bihar is approximately 28% (NHSRC, Nursing services in Bihar, 2009). Apart from shortage in

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numbers, inadequate level of clinical competency of these nurse-midwives is another challenge in improving quality of MNH services especially in remote areas. In 2008–09, the National Health Systems Resource Center of India conducted a study on the nursing services in Bihar and reported overall quality of nursing-midwifery education in existing institutions as grossly sub-optimal (NHSRC, Nursing services in Bihar, 2009). The study also highlighted other key concerns like inadequate faculty strength, infrastructure, suboptimal academic/clinical training, and poor structural management in the existing nursing education system. A high variance in the knowledge and clinical skills of the available faculty was also observed. The report also flagged an urgent need to improve institutional teaching methods, student evaluation system, and inclusion of advance practical training methodologies for betterment of the overall educational quality.

During the past decades, with the advancement in modern information technology, use of Internet for knowledge sharing and teaching has increased tremendously. Several studies have demonstrated that virtual classrooms are an efficient and effective way to enhance students' learning (Bertsch et al., 2007; Hortos et al., 2013; Mosalanejad et al., 2014). A virtual classroom is a set up where qualified trained faculty located at the central institution teaches a class of students in remotely located schools through Internet-based information technology interphase. A study was conducted to evaluate the effectiveness of virtual versus traditional teaching in achieving competencies among nursing students in Iran. The study reported that virtual teaching was more effective in achieving higher theoretical knowledge but no significant difference was found between the virtual and traditional teaching groups on practical competencies through objective structured clinical examination (OSCE) (Mosalanejad et al., 2014).

The usefulness of lectures attended via interactive video conferencing versus in-person was studied among 52 medical students attending a University of Vermont medicine clerkship program in the United States. Students were asked to attend half of the lectures in person and the rest half via videoconferencing. The mean student scores attending lectures via both methods were found almost similar, suggesting that technology-mediated learning can be used for effective clinical learning at off-site locations (Bertsch et al., 2007). Another study conducted to understand the level of satisfaction also generated evidences for its acceptability among the users (Callas et al., 2004).

Considering the current shortage of nursing-midwifery faculty and resultant sub-optimum educational quality in most ANM and GNM schools of Bihar, we implemented a virtual classroom training program in selected ANM and GNM schools, with the college of nursing (CoN), Indira Gandhi Institute of Medical Sciences (IGIMS), Patna, as an instructor location as it had adequate training infrastructure and trained faculty. The objective of this intervention was to improve the knowledge and skills of nursing-midwifery students.

The Virtual Classroom Training Program

CISCO is an American multinational corporation having expertise in designing and manufacturing high-quality networking equipment. Using Cisco's Education Enabled Development (CEED) technology, virtual classrooms were established in 4 ANM and 3 GNM institutions of Bihar, India. Another virtual classroom was established at CoN, IGIMS Patna, as an instructor location. CEED is an energy-efficient cloud-based video interaction solution, developed by Cisco technologies, with a vision to provide quality education to rural areas at a very affordable price of less than 1 US dollar per child per month (Cisco's 'Dwara' to connect educators, 2013). This method allows teachers and students from remote areas to connect with experts from urban settings (instructor location) through live streaming of training sessions for efficient delivery of education and skills development courses. Each virtual classroom was having some basic technology components needed for successful operation like CEED box, central processor unit integrated with a liquid crystal display (LCD) projector. All peripheral components like Internet line, public address (PA) system, universal serial bus (USB) drives, keyboard, camera were connected to it.

A 72 hour virtual training package was developed by Jhpiego—an international health organization affiliated to John Hopkins University, based on national curricula for second-year ANM and third-year GNM students, incorporating evidence-based techniques such as case-based learning, clinical simulations, demonstrations, practice, and feedback. The training package was focused on building midwifery knowledge and clinical skills of students in areas like antenatal, intra-partum, immediate post-partum, and neonatal care. This virtual classroom training using 72 hour package was designed as a supplement to regular classroom training. Almost all essential MNH practices which a competent nurse-midwife is supposed to know like management of second stage of labor (mgt. of SOL), active management of third stage of labor (AMTSL), essential new born care (ENBC), new born resuscitation (NBR), plotting of partograph, infection prevention (IP), methods of family planning were included in this comprehensive training package. Virtual training using this package was conducted for final-year GNM students of 2 schools from September 2013 to December 2013. Table 1 illustrates component-wise breakdown of the 72 hour training package.

This study was designed to evaluate the effectiveness of this virtual classroom training in improving the MNH knowledge and clinical skills of nursing-midwifery students using OSCE as the evaluation tool. Although some earlier studies demonstrate the benefits of virtual training, to the best of our knowledge, there are no studies conducted so far to assess the effectiveness of virtual training in improving knowledge and clinical skills of nursing-midwifery students in resource-constrained settings like India. It was anticipated that the findings from the study will add to the existing knowledge base and help find solutions to address the current shortfall in nursing faculty and find ways to improve institutional capacity and quality nursing education in resource-limited settings.

Methods

Study Design

This was a pre- and post-intervention study design to evaluate the effectiveness of virtual classroom training in improving knowledge and clinical skills related to MNH among GNM students. Pre- and post-intervention data were collected from the students from 2 participating GNM schools of Bihar. Complete study data were gathered in two phases approximately 12 months apart. Pre- and post-intervention data were collected in the month of March 2013 and Feb 2014, respectively.

Study Site and Population

All available students from the selected 2 GNM schools, i.e. Shri Krishna Medical College and Hospital (SKMCH), Muzaffarpur, and Patna Medical College and Hospital (PMCH), Patna, of Bihar who were in their final year of enrollment and had completed their course work in maternal and neonatal health were invited to participate in the study. To start with, students from both the GNM schools were assessed for their MNH knowledge and clinical skills. A 72 hour standardized

Table 1
Breakdown of 72 hour virtual classroom training package.

S. No	Components	No. of hours
1.	Antenatal care	17
2.	Intra-natal care and immediate postpartum care	27
3.	Postnatal care	6
4.	Newborn care	8
5.	Family planning	4
6.	Others	10
	Total	72

training package was then administered among the final-year students from the next batch along with their attendance of regular teaching sessions. Post-intervention data were collected from the trained cohort who had attended the virtual classroom training.

The pre and post cohorts included in the study were different as the intervention was targeted at the final-year students. The 72 hour package was administered to a new batch of final-year GNM students as the cohort assessed at pre-intervention had already passed out by the time the intervention was implemented.

Sample Size

Sample size calculation was not conducted as all eligible students were invited to be a part of this assessment. In 2013, prior to implementation of the intervention, 83 GNM students out of the total, i.e. 94, from 2 GNM schools were assessed for their competencies in key MNH skills using the OSCE method. The rest of the students were either denied or absent during the day of assessment. Conversely, all 92 students who attended virtual training participated in the post-intervention assessment for skill assessment. Competency of a student was defined as a score of 75% or above in the OSCE (averaged across 6 stations).

Data Collection Tools and Process

A standardized pre-tested OSCE checklist was used for clinical skill assessment of the students. The questionnaires of the checklist were broadly divided into six sections to cover some of the key MNH practices taught as a part of the intervention. Each section of the OSCE checklist was designed to test clinical decision making skills of the students against the pre-determined standards. Two of the sections , i.e. use of partograph and infection prevention, were nonobserved practices and signified 'knowledge' whereas four sections, i.e. management of second stage of labor, active management of third stage of labor, essential newborn care, and newborn resuscitation, were the observed practices and signified 'clinical skills'. For observed practices, student clinical knowledge and skills were evaluated with the use of simulation models and mannequins against the set OSCE standards. For plotting of partograph and infection prevention, scenario-based questions were administered among participants as a part of knowledge assessment related to those practices. One skill station for each given practice of the checklist was established and scoring was done against each critical step which is essential to be performed as subsets to complete a given practice. The participants were evaluated in batches and it was ensured that the groups of students waiting to be evaluated did not get exposed to the OSCE stations before the evaluation. On an average, 10 minutes' time was allotted to perform a skill at each station. The total duration to complete OSCE assessment for 6 participants was approximately 60 minutes and the maximum possible OSCE score a participant can attain was 76. All participants were evaluated using the same standardized checklist by a group of standardized observers of Jhpiego, India, trained by the study investigator team prior to start data collection.

Statistical Analysis

Data were analyzed using software package 'STATA' version 13 (StataCorp. 2013. Stata Statistical Software: Release 13. College Station, TX: StataCorp LP). The mean scores of participants at pre- and post-intervention assessments were compared and tested for statistical significance using paired t-test. Differences in the two groups for their competencies were also calculated using Pearson chi-square test. Maximum allowable alpha error considered was 5%. Linear regression modeling with robust standard error estimation was also performed to adjust the clustering effect by school.

Table 2
Background information of the schools that participated in the assessment.

GNM institutions	Pre-intervention	Post-intervention
Number of schools assessed	2	2
Number of students available	94	92
Number of students attended OSCE	83	92

Ethical Consideration

This study was approved by the institutional review board of Johns Hopkins University. Before initiating the study, each member of the research team of Jhpiego, India, involved in data collection received a research ethics training to improve their understanding of study objectives, how to obtain informed consent and maintain participants' privacy and confidentiality throughout the data collection using John Hopkins School of Public Health (JHSPH) Institutional Review Board (IRB) Human Subject Research Ethics Field Training Guide (JHSPH, 2009). A verbal informed consent was obtained from all the participants prior to start their OSCE assessment.

Results

Table 2: Contains background information of the students who participated in the assessment. 83 out of 94 third-year GNM students were assessed for their competencies in key MNH skills using a structured OSCE checklist prior to implementation of the intervention. Subsequently, a total of 92 students from the next batch of the same institutions was then underwent a 72 hour virtual training and then were assessed as post-intervention group for the same skills. While applying the test of normality (Shapiro–Wilk test) on the OSCE scores each cohort, it was found that they followed a normal distribution ($p > 0.05$). The mean student score assessed prior to intervention was 21.3 out of 76 (95% CI, 19.9–22.6) which increased to 62.0 (95% CI, 60.3–63.7) after the intervention. Statistically significant difference in the mean scores (40.6) of students is seen between pre- and post-intervention assessment ($p < 0.001$). The mean scores in each station at pre- and post-intervention is elaborated in Table 3. The mean difference in each station was also statistically significant. The pre- and post-intervention changes in the mean scores related to individual practices are given in Table 3.

Reasonable level of skills associated with competency of a student in key MNH practices was defined as a score 75% or above in the OSCE, across the six stations. Surprisingly, none of the students assessed prior to the intervention were found to have the reasonable level of skills associated with competency. However, at post-intervention, a

Table 3
Comparison of pre- and post-intervention scores among the students who attended OSCE.

Name of the practice	Mean score (pre-intervention)	Mean score (post-intervention)	Mean difference	P value
1.Management of second stage of labor	2.3	9.6	7.2	<0.001
2.Active management of third stage of labor	1.8	8.8	6.9	<0.001
3.Essential newborn care	2.2	8.0	5.7	<0.001
4.Newborn resuscitation	0.6	8.8	8.2	<0.001
5.Partograph filling	1.3	7.4	6.7	<0.001
6.Infection prevention	12.8	19.0	6.2	<0.001
Total score	21.3	62.0	40.6	<0.001

Table 4
Comparison of competency among the students who attended OSCE.

Competency status	Competent[a]	Needs improvement	Total	P value (chi-square)
Pre-intervention number (%)	0(0)	83 (100)	83	<0.001
Post-intervention number (%)	71 (77.2)	21 (22.8)	92	

[a] Competency of a student was defined as score of 75% or above in the OSCE (averaged across 6 skill stations).

substantial difference has been observed in the competency where 77.2% of the participants were found competent (Table 4), and this difference was statistically significant. Competency as an outcome was difficult to model as no one was having this as an outcome at pre-intervention stage. Therefore, linear regression modeling was performed adjusting for the clustering effect with robust standard error estimation. On an average, a student at post-intervention scored 52.3% (95% CI, 49.4%–55.3%) marks more than the student at pre-intervention. The average difference in score between the schools was 4.9% (95% CI, 1.9%–8.0%) adjusting for pre-intervention and post-intervention (Table 5).

Discussion

The virtual classroom program was designed with an objective to provide quality MNH training to nursing-midwifery students from institutions with limited infrastructure and faculty strength. It was envisioned that utilization of evidence-based scientific innovations like virtual classrooms training could be an efficient and effective strategy to address local needs of quality education and training for nursing-midwifery students in Bihar.

This study aimed to evaluate whether virtual classroom trainings can improve key MNH-related clinical skills of the nursing-midwifery students using a pre–post study design. The findings of the study reveal a statistically significant change in the mean OSCE score of the students. Also a much higher number of students were found competent in the key MNH (scored 75% or more in OSCE) skills post-intervention compared to none during pre-intervention assessment. Even when adjusted for clustering using linear regression analysis, the students during post-intervention scored 52.3% more marks than pre-intervention. To the best of our knowledge, no studies in the literature of midwifery have shown effect of virtual classrooms in improving the clinical skills of the nursing students in resource-constrained settings.

Though the utilization of similar classroom setting has been studied, no statistically significant differences in the mean scores were found between the students who attended lectures via interactive video conferencing from the remote locations versus in-person while attending medicine clerkship program (Bertsch et al., 2007). Another study while evaluating the effectiveness of live lectures delivered via video-conferencing with that of in-person lectures also reported no statistically significant difference in the performance of medical students who attended the national licensing examination (Hortos et al., 2013). In our study, although the context and location of study were different, statistically significant differences in the mean scores have been observed in the group of students assessed before and after the implementation of the virtual classroom training program.

Table 5
Linear regression of the mean scores adjusted for clustering by schools.

Variable	Adjusted mean difference (95% CI)	P value (t-test)	Coefficient of determination Overall P value (F test)
Pre–post-intervention	52.34 (49.4–55.3)	<0.001	0.9
Difference between PMCH and SKMCH	4.9 (1.9–8.0)	<0.001	<0.001

Additionally, while evaluating the effectiveness of virtual versus traditional learning, a significant increase in the mean scores in the theoretical exams but not in practical competencies for the students who attended virtual sessions versus the traditional learning group were observed (Mosalanejad et al., 2014). A study conducted in India to evaluate the effectiveness of video-assisted teaching module also concluded that it was highly effective in improving the knowledge of nursing students regarding care of dementia patients (Austin and Balasubramanian, 2012). On the other hand, our study on virtual classroom effectiveness revealed a statistically significant improvement in the practical skills of the students related to MNH. The reason for such a drastic improvement might be that the intervention was focused and designed in such a way where students were encouraged, trained for improving their practical skills.

Competency can be best evaluated in a clinical setting based on hands-on experiences. Considering the students' status, time, and logistics, the best proxy to assess competency was to assess skills associated with it through simulation models.

Our study was a pre- and post-intervention study without a control group as a control group was not feasible due to logistic reasons. Although sample size was not calculated and all willing students were invited to participate, the post hoc power calculation showed a power of more than 90%, hence it makes the study valid. Additionally, the student cohorts assessed before and after the intervention were different as the intervention was targeted at the final-year students who have completed coursework on maternal and new born health, which was one of our inclusion criteria for recruiting the participants. It was unrealistic to assess the same cohort of students before and after implementation of the program. The students whom we assessed at pre-intervention had already completed their course work on MNH skills through traditional learning method before the implementation of virtual classroom training. The post-intervention assessment was conducted among the other cohort of students who have attended 72 hour virtual classroom training along with attendance of regular teaching sessions similar to an earlier cohort. Addressing the time lag between two assessment (pre- and post-intervention), an assumption was made that there would be no significant difference between characteristics of students passing out subsequently from the institutions.

Our study indicates that virtual classroom training is effective in enhancing knowledge and clinical skills of nursing-midwifery students in resource-constrained settings, especially where trained faculty are not available in adequate numbers. Considering the existing shortfall in faculty in nursing educational institutions as well as the sub-optimal educational quality, this technology-based approach could be utilized in consort with traditional learning for student skills enhancement. In the long term, this can help us to improve the quality of graduating nurse-midwives, thereby improving the quality of service provision at the sites where these GNM graduates are posted in the future. Although the tracking of these capacity-built graduate nurse-midwives till their employment will be helpful to understand the long-term impact in reducing maternal and neonatal morbidity and mortality in the study state of India, this was beyond the scope of this virtual classroom training program. Though the outcome of this program is promising, a long-term follow-up of nursing graduates who were trained through virtual classroom training can identify the real impact of the program in improving the standards of care being delivered by them at the time of their deployment to health facilities.

Conclusion

The findings of our study suggest that the knowledge and skills of nursing-midwifery students can be enhanced by leveraging virtual training concept blended with traditional classroom learning. Addressing the current issues of sub-optimal nursing education, infrastructure,

and shortage of faculty, this approach can be utilized to deliver high-quality MNH training to nursing-midwifery students based at remotely located institutions.

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